

Specification:

Page 5, beginning line 17:

In practice, the two phase electrolyte system of the present invention realizes significant advantages over the prior art. Because the halogen-containing compound is substantially immiscible ~~not miscible~~ in the non-aqueous electrolyte solution, there is little ingress of the halogen-containing compound into the regions within the casing occupied by the non-aqueous electrolyte solution, i.e. in the casing regions separating the positive and negative poles and defined by the separator. As such, there is little interference by the halogen-containing compound in electrochemical reactions occurring at the poles and in the non-aqueous electrolyte solution. Further, the secondary cell is superior in terms of initial capacity and cycle characteristics. Moreover, the halogen-containing compound of the present invention interferes and/or inhibits combustion reactions that may result upon piercing or compression of the battery. Accordingly, the energy storage device of the present invention exhibits enhanced safety over prior art secondary cells.

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Energy storage devices may be prepared using the electrolyte system of the present invention as follows. A method of making an energy storage device in accordance with the present invention comprises providing an electrode assembly including a first electrode member, a second electrode member, and a separator member physically and electrically separating the first electrode member from the second electrode member but capable of allowing ionic conductivity contact between the first

electrode member and the second electrode member, placing the assembly in a casing, and filling the casing with the electrolyte system that is herein described by first, filling the casing at least partially with the non-aqueous electrolyte solution, waiting a period of time sufficient for the non-aqueous electrolyte solution to penetrate one or more pores of the electrode assembly, and then adding the flame retardant material to the casing. The method of making the energy storage device may further comprise the step of charging the energy storage device after adding the non-aqueous electrolyte solution. After filling the casing at least partially with the non-aqueous electrolyte solution, the energy storage device may be charged either before or after adding the flame retardant material to the casing.

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Within the battery casing, the non-aqueous electrolyte solution selected in accordance with the present invention and the halogen-containing compound selected in accordance with the present invention form two separate liquid phases. Since the non-aqueous electrolyte solution and the halogen-containing compound are substantially immiscible, one liquid phase within the battery casing is mainly non-aqueous electrolyte solution and the other liquid phase in the battery casing is mainly halogen-containing compound. In accordance with the present invention, the non-aqueous electrolyte solution phase occupies the region within the casing between the positive pole and the negative pole defined by the separator. As a result, the halogen-containing compound is substantially not in the region between the positive pole and the negative pole defined by the separator and does not interfere with the oxidation-reduction processes at the poles and in the non-aqueous electrolyte solution. However, the halogen-containing compound

tends to inhibit the occurrence of highly energetic events such as combustion processes and therefore increases battery safety. Applicant believes the halogen-containing compound may interfere with the production of highly energetic and highly reactive carbon radicals produced in combustion processes and/or interfere with chain reaction processes by production of fluoride radicals.

Paragraph page 18, beginning line 19:

The principle principal preferred embodiments and modes of operation of the present invention have been described. The invention described herein, however, is not intended to be construed as limited to the particular forms disclosed, since they are regarded as illustrative rather than restrictive. Variations and changes may be made by those skilled in the art without departing from the spirit of the invention.

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Table 1

Additive name	Discharge capacity (%)	Safety level	EC ratio (wt%)	DEC ratio (wt%)	LiPF ₆ ratio (wt%)	Additive ratio (wt%)
none	100.0	4	31.2	53.7	15.1	0
perfluoro-1,3-dimethylcyclohexane	96.3	1	21.84	37.59	10.57	30
	93.7	2	21.84	37.59	10.57	30
FC-70	99.5	2	21.84	37.59	10.57	30
	100.5	2	21.84	37.59	10.57	30